

IN THE UNITED STATES DISTRICT COURT  
FOR THE DISTRICT OF DELAWARE

GTECH CORPORATION,

Plaintiff,

v.

SCIENTIFIC GAMES INTERNATIONAL,  
INC., SCIENTIFIC GAMES HOLDINGS  
CORPORATION, SCIENTIFIC GAMES  
FINANCE CORPORATION, and  
SCIENTIFIC GAMES CORPORATION,

Defendants.

C.A. No. 04-138-JJF

**REDACTED VERSION**

**DECLARATION OF MICHAEL KEEFE, Ph.D., P.E.**

1. I am an Associate Professor in the Department of Mechanical Engineering at the University of Delaware, where I have worked since 1985. I received my Ph.D. in Mechanical Engineering from the University of Minnesota in 1985. I received my M.S. in Mechanical Engineering from the University of Minnesota in 1980, and my B.S. in Mathematics from the University of Notre Dame in 1978. From 1980-85, I worked for Honeywell, Inc., where I was responsible for performing finite-element analysis of hydrodynamic phenomena and developing numerical models for predicting performance.

2. At the University of Delaware, I teach courses covering Machine Design: Kinematics & Kinetics, Machine Elements and Computer-Aided Design. I also regularly teach the junior and senior design courses. The junior design courses primarily involve the analysis of machines that use linkage, cam and gear mechanisms. For the senior design course, I have been the faculty advisor to teams where the solution has involved the design and preliminary

development of a machine or a machine element, including most recently a non-drip valve system, a small-roll cutter, and a biaxial fabric testing machine.

3. I am a registered Professional Engineer in the State of Delaware, and was named Engineer of the Year in 2005 by the Delaware Engineering Society. I am also a member of the American Society of Mechanical Engineers, the National Society of Professional Engineers, and the Fiber Society.

4. I have inspected Scientific Games' PlayCentral Kiosk and examined the burster mechanism used in that machine.

5. A copy of my *curriculum vitae* is attached as Exhibit A.

The '337 Patent

6. It is my understanding that GTECH is asserting that Scientific Games' PlayCentral machine infringes claims 20 and 21 of U.S. Patent No. 4,982,337 ("the '337 patent").

7. The '337 patent describes a lottery ticket vending machine that is designed to sit on a countertop (col. 7, ll. 3-5). The tickets are stored in the machine in fan-fold form (col. 9, ll. 20-24). The machine is operated by an agent, and has a front surface with a control panel that includes a keypad and push-buttons for use by the agent (col. 2, ll. 49-54; col. 7, ll. 5-9, 14-21, 41-44). The rear surface of the machine faces the customer, and includes an opening through which the tickets are dispensed to the customer (col. 2, ll. 49-54; col. 7, ll. 10-11).

8. The '337 patent describes a mechanism for separating the tickets that uses a movably mounted dull edge "burster wheel," which exerts pressure on the perforations between the tickets to separate them (col. 3, ll. 55-57; col. 10, ll. 58-63). The separation mechanism described in the patent also has two sets of rollers -- one set on each side of the perforation to be

separated -- which hold the strip of tickets in tension as the burster wheel is brought into contact with the tickets (col. 3, ll. 57-59; col. 10, ln. 64 - col. 11, ln. 2). The burster wheel is moved into contact with the tickets by a bursting blade drive means that includes a burster block, a motor, a cable spool arrangement, and a tensioning spring (col. 3, ll. 60-63; col. 13, ll. 24-26).

The '624 Patent

9. It is my understanding that GTECH is asserting that Scientific Games' PlayCentral machine infringes claim 18 of U.S. Patent No. 5,222,624 ("the '624 patent").

10. The '624 patent describes a lottery ticket vending machine, which is said to be an improvement over the vending machine described in the '337 patent. *See '624 patent, col. 1, ll. 9-13, 24-26* ("Described in my joint U.S. patent application . . . now U.S. Pat. No. 4,982,337, is a lottery ticket dispensing mechanism which is very advantageous. . . . Although the machine of the above-described pending application is highly advantageous, it is an object of the present invention to improve on it . . .").

11. The improvement described in the '624 patent is the use of windows on the front of the vending machine to display for customers actual tickets that move as the tickets are dispensed. *See '624 patent, col. 1, ll. 45-49* ("The machine preferably has one or a plurality of windows with mechanism for moving an array of lottery tickets past each of the windows so that different types of lottery tickets can be seen, but not touched, by the customers."). The purpose of the improvement is to provide a vending machine that "is improved in its ability to communicate to the customer the tickets available and to enhance customer confidence in the machine" (col. 1, ll. 26-29). This is achieved by providing a machine in which "a representation of the tickets is displayed by the machine at all times so that customers can see what they are

buying. Then, as the tickets are being dispensed, the visible representation moves by an amount corresponding to the number of tickets dispensed" (col. 1, ll. 37-42; *see also* col. 2, ll. 1-7).

12. The '624 patent also describes an alternative video display embodiment in which a video screen is used to simulate windows with moving tickets: "In another embodiment of the vending machine, graphic representations of the lottery tickets are displayed on a video screen, rather than through windows. The lottery ticket images are moved in the same manner as tickets are moved past windows" (col. 1, ll. 64-68).

The PlayCentral Kiosk

13. Scientific Games' PlayCentral Kiosk is a customer-activated vending machine that is capable of dispensing instant lottery tickets. The cabinet for the PlayCentral machine has a touch screen display on the front surface for use by customers in ordering tickets. There is also an opening on the front surface of the machine for the player to retrieve the tickets purchased.

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Claim 20 Of The '624 Patent

A. "Means for Separating"

15. Claim 20 requires a "means for separating each of said tickets from said strip." The structure disclosed in the '337 patent for the means for separating has three distinct parts -- all of which must work in combination to perform the function of separating the tickets: "[i] a dull edge bursting blade moveably mounted adjacent a predetermined bursting position along the path, [ii] holding means for holding the stream of tickets against substantial deflection from the path at the bursting position, and [iii] bursting blade drive means for bringing the bursting blade into bursting contact with the stream of tickets at the bursting position to burst the leading ticket from the next following ticket" (col. 3, ll. 55-63).

16. The "dull edge bursting blade moveably mounted" disclosed in the '337 patent is a circular burster wheel with a dull, rounded edge: "burster wheel 68 is advantageously in the form of a circular burster blade which . . . has a dull, rounded edge . . ." (col. 10, ll. 58-63). The structure disclosed in the '337 patent for the holding means is two sets of rollers -- one set on each side of the perforation to be separated -- which hold the strip of tickets in tension as the burster wheel is brought into contact with the tickets (col. 10, ln. 64 - col. 11, ln. 2). The structure disclosed in the '337 patent for the bursting blade drive means is a burster block, burster motor, cable spool arrangement, and tensioning spring (col. 13, ll. 23-31).

17. The separating mechanism in the PlayCentral is not identical or equivalent to the separating mechanism disclosed in the '337 patent. The PlayCentral machine does not

have a moveably mounted circular burster wheel with a dull, rounded edge. The PlayCentral machine does not have two sets of rollers that hold the strip of tickets on either side of the perforation to be separated. The PlayCentral machine does not have any structures that cause the bursting blade to move.

18. The blade used in the PlayCentral is a flat, pointed, stationary blade, which is significantly sharper than the dull, rounded-edge, burster wheel described in the '337 patent. The blade used in the PlayCentral would not work in the mechanism described in the '337 patent -- it would not "roll" along the perforation nor even traverse the length of the perforation without substantial modifications to the mechanism. Conversely, the wheel described in the '337 patent would not work in the PlayCentral machine. The bursting blade in the PlayCentral machine uses its point to lock into a perforation as the ticket strip is reversed using rollers on one side of the perforation. The dull, rounded-edge burster wheel of the '337 patent would not lock into a perforation.

19. The two sets of rollers described in the '337 patent hold the strip of tickets on each side of the perforation to be separated. The strip of tickets in the PlayCentral is held on only one side of the perforation to be separated. This difference is not insubstantial. If the mechanism described in the '337 patent held the strip of tickets on only side (as the PlayCentral does), the burster wheel of the '337 patent could not be used to separate the tickets. The strip of tickets would be deflected away from the burster wheel, and the tickets would not be separated. Conversely, holding the strip of tickets with rollers on each side of the perforation to be separated would not work in the PlayCentral, because it would prevent the strip of tickets from being pulled back against the bursting blade to separate the leading ticket.

20. Because the blade in the PlayCentral is stationary, there are no structures in the PlayCentral machine that cause the bursting blade to move, and there are no structures in the PlayCentral machine that perform the function of the bursting blade drive means described in the '337 patent.

21. The mechanical differences between the mechanism of the '337 patent and the mechanism of the PlayCentral machine are not insubstantial. The mechanism described in the '337 patent uses three separate motors -- one motor drives the rollers on one side of the perforation, another motor drives the rollers on the other side of the perforation, and a third motor is used to cause the burster wheel to come into the contact with the perforation and traverse the strip of tickets. The three motors of the '337 patent each cause a load to be applied to the strip of tickets. These loads increase tension in the ticket, ultimately causing the leading ticket to be separated from the strip of tickets. The exit rollers (and their associated motor) apply a load in the downstream direction of the strip of tickets, and the feed rollers (and their associated motor) apply a load in the upstream direction of the strip of tickets -- together causing an initial tension in the ticket. The dull, rounded-edge burster wheel (and its associated motor and mechanism) then applies a load on the strip of tickets in the downward direction at the perforation to be separated (*see* '337 patent, Figures 8A and 8B). Because the strip of tickets is being held on both sides of the perforation and thus unable to move, this downward load acts to stretch the ticket -- further increasing the tension in the ticket.

22. The mechanism in the PlayCentral machine, by contrast, uses a single motor, which moves the strip of tickets past the bursting blade, and then reverses and backs up the strip of tickets, causing the perforation to be separated to be brought into contact with the bursting blade. The only load applied to the strip of tickets in the PlayCentral machine during

bursting is in the upstream direction of the strip of tickets, as the ticket is reversed and the perforation to be separated is brought into contact with the bursting blade. The tip of the PlayCentral blade locks into a perforation, and the continued load in the upstream direction puts the perforation into tension. There is no other load applied to the strip of tickets in the PlayCentral machine during bursting.<sup>1</sup> The difference in the number of motors (and how they operate in their respective mechanisms) and the difference in the loads applied in the mechanism of the ‘337 patent and the load applied in the mechanism of the PlayCentral machine highlight the substantial differences in the two mechanisms.

23. In short, the way the mechanism in the PlayCentral machine separates tickets is substantially different from the way the mechanism described in the ‘337 patent separates tickets.

B. “Dispensing Means”

24. Claim 20 also requires a “dispensing means for dispensing tickets through said outlet opening.” The structure disclosed in the ‘337 patent for the “dispensing means” is a pair of exit rollers 64, 66 (col. 10, ll. 45-51). There is no structure in the PlayCentral machine that is equivalent to the kick-out rollers described in the ‘337 patent. Gravity is not a structure.

C. “Housing Means”

25. Claim 20 of the ‘337 patent requires a “housing means for storing a strip of tickets to be dispensed, said housing means having an outlet opening accessible to the purchaser of the tickets from said machine.”

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<sup>1</sup> The strip of tickets is bent as the tickets move past the blade and the gate closes. But once the ticket is folded and permanent damage has occurred, the tensile stress is relieved, and the strip of tickets is not in a tensioned state when the motor is reversed.

26. The only structure described in the ‘337 patent for “storing a strip of tickets to be dispensed” is “a box-like module having opposed front and back surfaces, . . . control panel means mounted at the front surface of the module . . . [and] a dispensing outlet manually accessible at the back surface for receiving a dispensed lottery ticket . . .” (col. 3, ll. 29-37). *See also* ‘337 patent, Abstract (“The tickets are dispensed at one end of the unit which faces the customer. A control panel for the vendor is located at the opposite end”); col. 7, ll. 5-16 (“Unit 14 includes a housing with a front surface 28 which . . . is intended to face the sales agent or vendor standing behind a counter 26. An opposed back surface 30 of unit 14 is intended to face the customers . . .”). The drawings in the patent are consistent with this description. Figures 3 and 4 of the patent depict a housing that has a front surface with a control panel, and a back surface with a dispensing outlet.

27. The PlayCentral machine does not have the “housing means” described in the ‘337 patent and required by claim 20 of the patent. The PlayCentral machine does not have a front surface that faces the sales agent, and a back surface that faces the customer. The PlayCentral machine is a customer-operated terminal with customer-operated touch-screen controls and a dispensing outlet on the front surface of the housing. The difference between a clerk-operated terminal that dispenses tickets directly to the customer from an opening in the back surface of the housing (as described in the ‘337 patent) and a customer-operated terminal (like the PlayCentral) is not insubstantial. Indeed, the ‘337 patent itself stresses over and over again the importance of having a control panel on the front side of the machine and a dispensing outlet on the back side. A machine with both of those structures on the same side is substantially different than the machine described in the ‘337 patent.

Claim 18 Of The '624 Patent

28. Claim 18 of the '624 patent requires a "means for dispensing said tickets in a number corresponding to the amount of money input into said machine by said customer."

29. The keypad may be where the dispensing process starts and the receptacle may be where the dispensing process ends, but it is also necessary to feed the tickets through the mechanism, and to separate the correct number of tickets. The only structure disclosed in the '624 patent for feeding and separating the tickets is the "lottery ticket dispensing mechanism" of the '337 patent ('624 patent, col. 1, ln. 12), which is incorporated by reference (col. 4, ll. 48-55). Figures 4 and 5 of the '624 patent depict "lottery ticket feed and dispensing mechanisms" as disclosed in the '337 patent, "except that [they have] been rotated through 90° to dispense tickets downwardly" (col. 4, ll. 10-14; col. 4, ll. 50-52).

30. As with the "dispensing means" of claim 20 of the '337 patent, there is no structure in the PlayCentral machine that is equivalent to, or insubstantially different from, the outfeed rollers of the '624 patent. Gravity is not a structure.

31. If the "means for dispensing" of claim 18 of the '624 patent is properly interpreted to include the feeding and bursting mechanism of the '337 patent, the PlayCentral machine does not have the required "means for dispensing" for all the reasons discussed above as to why the PlayCentral machine does not have the "means for separating" of claim 20 of the '337 patent.

I declare, under penalty of perjury, that the foregoing is true and correct.

Date: November 14, 2005

Signed:   
Michael Keefe, Ph.D., P.E.

# EXHIBIT A

Michael Keefe, Ph.D. P.E.  
Mechanical Engineering Department

Phone: 302-831-8009  
University of Delaware

FAX: 302-831-3619  
email: keefe@me.udel.edu

Dr. Michael Keefe joined the University of Delaware, Department of Mechanical Engineering, in 1985 after completing a Ph.D. in Mechanical Engineering from the University of Minnesota. A Registered Professional Engineer in the State of Delaware, his research interests have involved the integration of solid modeling into design engineering – currently studying the dynamic event of ballistic impact on fabric structures as well as complex geometries involved in joining and manufacturing fabrics. Other work has focused on synthesizing elastic mechanisms, developing an interactive aid for undergraduate machine-design kinematic education, and rapid prototyping. Prior to joining the University of Delaware, Dr. Keefe was employed by Honeywell Inc., where his responsibilities included performing finite-element analysis of hydrodynamic phenomena and developing numerical models for predicting performance. He currently serves as the Mechanical Engineering Department's Associate Chairman for Undergraduate Education.

#### **Education:**

Doctor of Philosophy, Mechanical Engineering, University of Minnesota, Minneapolis, MN, June 1985  
Master of Science in Mechanical Engineering, University of Minnesota, MN, August 1980.  
Bachelor of Science in Mathematics, University of Notre Dame, Notre Dame, IN, May 1978.

#### **Professional Experience:**

Sept. 00 - present: Associate Chairman for Undergraduate Education, Mechanical Engineering,  
University of Delaware, Newark, Delaware  
Sept. 90 - present: Associate Professor, Mechanical Engineering, University of Delaware.  
Sept. 85 - Aug 90: Assistant Professor, Mechanical Engineering, University of Delaware.  
Aug. 80 - Aug 85: Development Engineer, Honeywell Inc., Minneapolis, Minnesota.

#### **Recent Journal Publications:**

- Duan, Y., M. Keefe, T Bogetti, B. Cheeseman, "Modeling Friction Effects on the Ballistic Impact Behavior of a Single-Ply High-Strength Fabric," *International Journal of Impact Engineering*, Vol 31, Issue 8, pp. 996-1012, 2005
- Duan, Y. M. Keefe, T. Bogetti, B. Cheeseman, B. Powers, "Modeling the Role of Friction during Ballistic Impact of a High-Strength Plain-Weave Fabric," *Journal of Composite Structures*, Vol. 68, No. 3, pp. 331-337, 2005 (journal article corresponding to ACS 18th Annual Conference paper, October 2003).
- Tang, W., M. Keefe, "Stress Analysis and Structural Modifications of a Polyester Double-Tape Seam," *Journal of Materials: Design and Applications*, Proceedings of the Institution of Mechanical Engineers (Part L), Vol. 217, Part L2, pp. 101-112, 2003.
- Aluru, R., M. Keefe and S. Advani, "Simulation of Injection Molding into Rapid-Prototyped Molds," *Rapid Prototyping Journal*, Vol. 7, No. 1, February 2001.
- Li, Y., E. P. Gargiulo and M. Keefe, "Studies in Direct Tooling Using Stereolithography," *ASME Journal of Manufacturing Science and Engineering*, Vol. 122, No. 2, May 2000, pp. 316-322.

#### **Book Chapter:**

"Geometric modeling of yarn and fiber assemblies," Chapter 4, pp. 138-158, *Microstructural characterisation of fibre-reinforced composites*, Edited by John Summerscales, Woodhead Publishing Limited, CRC Press, 1998.

Recent Refereed Conference Publications:

- Duan, Y., M. Keefe, E.D. Wetzel, T.A. Bogetti, B. Powers, J.E. Kirkwood, K.M. Kirkwood, "Effects of friction on the ballistic performance of a high-strength fabric structure," International Conference on Impact Loading of Lightweight Structure, May 8-12, 2005, Forianopolis, Brazil, 2005.
- Duan, Y. M. Keefe, T. Bogetti, B. Powers, "Finite Element Analysis of Transverse Impact on a Woven Textile," IMECE2004-61694, Proceedings of IMECE 2004, ASME International, Technical Session TEX-3, Saturday, November 13, 2004, Anaheim, California, 2004.
- Duan, Y. M. Keefe, T. Bogetti, B. Cheeseman, B. Powers, "Impact and Simulation of Fabric Response," accepted for American Society of Composites (ACS) 18th Annual Technical Conference, Impact and Energy Absorptions Sessions, Gainesville, Florida, October 19-22, 2003. (subsequently published in *Journal of Composites Structures*)
- Tang, W., M. Keefe, "Stress Analyses and Structural Modifications of Fabric Composite Seams," IMECE2002-34487, Proceedings of IMECE'02, ASME International, November 17-22, 2002, New Orleans, Louisiana.
- Duan, Y., M. Keefe, T. Bogetti and B. Cheeseman, "Modeling the Impact Behavior of High-Strength Fabric Structure," Fall 2002 Annual Conference, the Fiber Society, October 16-18, 2002, Natick, Massachusetts.
- Glancey, J.L., M. Keefe and S. Zhang, "Performance of High Oleic Soybean Oil-Based Hydraulic Fluids in Long-Duration Pump Tests," SAE Paper No. 2000-01-2556, Alternative Industrial Lubricants and Additives (Session Code: F30-B), SAE International Off-Highway and Powerplant Congress and Exposition, Midwest Express Center, September 11-13, 2000, Milwaukee, Wisconsin.

Membership in Professional Societies:

American Society of Mechanical Engineers (ASME)

Fiber Society

National Society of Professional Engineers (NSPE)

Delaware: Engineer of the Year – award presented February 24, 2005.

## Michael Keefe



University of Delaware, Mechanical Engineering

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Revised Spring 2005

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**OBJECTIVE:** *To conduct research that applies computer-aided engineering, solid modelling and system modelling by directing graduate and undergraduate students and to teach undergraduate and graduate engineering design courses.*

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- **CURRENT COURSES**

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- **EDUCATION**

- **EXPERIENCE**

- **TEACHING**

- **RESEARCH**

- **Publications**
- **Students**

- **SERVICE**

- **ASME Young Design Engineer's Paper Competition**

- **CONSULTING**

- **PERSONAL DATA**



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send email to: [keefe@me.udel.edu](mailto:keefe@me.udel.edu)

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**SUMMARY OF EDUCATION:**

- Ph.D., Major in Mechanical Engineering
  - University of Minnesota, Minneapolis, MN
  - Dissertation: "The Development of a Computer-Assisted Tool to Semi-Automatically Generate Three-Dimensional Facial Soft-Tissue Information," 1985.
- Master of Science in Mechanical Engineering
  - University of Minnesota, Minneapolis, MN
  - Thesis: "Facial Form Analysis through Computer-Aided Design," 1980.
- Bachelor of Science
  - University of Notre Dame, Notre Dame, Indiana, 1978.
  - Major in Mathematics

**DETAILS OF EDUCATION:**

- **Ph.D.**
  - University of Minnesota, Minneapolis, Minnesota
  - Graduation: June 1985, Major in Mechanical Engineering,
  - Supporting Program: mathematics, computer science.
  - Dissertation: "The Development of a Computer-Assisted Tool to Semi Automatically Generate Three-Dimensional Facial Soft-Tissue Information."
  - Abstract: Expand existing stereometric techniques by using structured light in a passive system and utilize computer graphics to create a system capable of clinically generating and displaying a quantitative representation of the complex facial surface.
  - Advisor: Dr. Donald R. Riley
- **Master of Science**
  - University of Minnesota, Minneapolis, Minnesota
  - Graduation: August 1980, Major in Mechanical Engineering.
  - Thesis: "Facial Form Analysis through Computer-Aided Design."
  - Abstract: Develop a methodology for generating three-dimensional data from a human face.
  - Advisor: Dr. Donald R. Riley
  - Awards:
    - Truth Incorporation Certificate of Participation for Mechanical Engineering Mechanism Design Course, June, 1979.
    - Graduate School Fellowship, 1978-1979.
- **Bachelor of Science**
  - University of Notre Dame, Notre Dame, Indiana
  - Graduation: June 1978, Major in Mathematics.
  - Awards:
    - Graduated summa cum laude, 1978.
    - Graduated first in the College of Science, 1978.
    - Senior General Electric Prize for Math Major, 1978
    - Frank F. Hering Memorial Scholarship, 1974-1978.

send email to: [keefe@me.udel.edu](mailto:keefe@me.udel.edu)

Return to  [Michael Keefe Home Page](#)

**SUMMARY OF EXPERIENCE:**

- 1990-date: Associate Professor
- 1985-1990: Assistant Professor
  - University of Delaware
  - Mechanical Engineering Department, Newark, Delaware 19716-3140,  
phone:(302)831-8009, fax:(302)831-3619, email: keefe@me.udel.edu
- 1980-1985: Development Engineer
  - Honeywell Incorporated, Minneapolis, Minnesota
- 1980-1984: Research Assistant
  - Division of Orthodontics, School of Dentistry, University of Minnesota, Minneapolis, Minnesota 55455
- 1978-1980: Teaching Assistant
  - Mechanical Engineering Department, University of Minnesota, Minneapolis, Minnesota 55455

**DETAILS OF EXPERIENCE:**

- **University of Delaware, Newark, Delaware**
  - Associate Chairman for Undergraduate Education, Mechanical Engineering, 2000-date.
  - Associate Professor 1990-date.
  - Assistant Professor 1985-1990.
  - Responsibilities: Develop a research program in computer-aided engineering. Teach under-graduate courses in mechanical design and computer-aided engineering; focal point for undergraduate education issues for the Mechanical Engineering Department. Develop and teach advanced (graduate level) courses in computer-aided design.
  - Courses taught (or co-taught)
- **Honeywell Incorporated, Minneapolis, Minnesota**
  - Development Design Engineer, part-time employee, 1980-1985.
  - Responsibilities: Assist in the design of weapon-system components through finite-element analysis; develop and implement simple computational tools.
- **Division of Orthodontics, School of Dentistry, University of MN**
  - Research Assistant, 1980-1984.
  - Responsibilities: Transfer and implement graphics software on a PDP 11/44 system; write the software needed to utilize the digital data from an image analyzer; work on the system to clinically generate three-dimensional facial data.
- **Mechanical Engineering Department, University of MN**
  - Teaching Assistant, 1978-1979.
  - Responsibilities: Grade homework and tests; conduct labs which included lecturing, testing and problem solving sessions. Courses: Mechanical Engineering System Analysis, Analysis of Mechanism Systems and Basic Measurements Laboratory.

send email to: [keefe@me.udel.edu](mailto:keefe@me.udel.edu)

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**TEACHING EXPERIENCE:****University of Delaware, Newark, Delaware**

- Associate Professor 1990-date.
- Assistant Professor 1985-1990.
- Courses taught (or co-taught):
  - prior curriculum: MEEG125 Intro to Engineering, Computer Methods
  - MEEG202 Computer Aided Engineering Design
  - prior curriculum: MEEG214 Mechanics II, Dynamics,
  - MEEG266 Independent Study, Undergraduate,
  - MEEG301 Machine Design-Kinematics & Kinetics,
    - replaced: MEEG347 Design I, Machine Kinematics & Kinetics,
  - MEEG304 Machine Design-Elements,
    - replaced: MEEG348 Design II, Machine Elements,
  - prior curriculum: MEEG361 Applied Engineering Analysis,
  - MEEG366 Independent Study, Undergraduate,
  - MEEG445/6 Undergraduate Research,
  - MEEG466 Independent Study, Undergraduate,
  - MEEG401 Senior Design, - co-teach,
    - replaced:
      - MEEG447 Senior System Synthesis I, Senior Design, - co-taught,
      - MEEG448 Senior System Synthesis II, Senior Design, - co-taught,
  - Senior Design Projects: 1985-current
  - MEEG467 Computer-Aided Parametric Solid Modeling,
  - MEEG663 Computer-Aided Design,
  - MEEG667 Experimental Vibration Analysis, - co-taught,
  - MEEG467/667 Design and Manufacture of Flexible Structures,
  - MEEG867 Advanced Computer-Aided Design,
  - MEEG867 Computer Vision - co-taught.

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send email to: [keefe@me.udel.edu](mailto:keefe@me.udel.edu)

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**CURRENT RESEARCH PROJECTS:**

- Modeling of Joints in Fabric Structures

For any fabric structure, the ability to understand how to join fabrics together and retain appropriate material properties is critical. Since patterns are flat and two dimensional yet the resulting structure will be three dimensional, joints (seams) are places of discontinuity and thus become potential failure initiation locations. The ultimate goal would be the ability to predict how joining affects the final structure and its response to load. The first phase is to create a model (based on similarities to composite structures) for heat-sealed seams and verify and validate the model. The work would then move to three-dimensional stitching and joining.

- Friction Effects (and other Parametric Studies) on Fabric Structures

Fabrics are often used in structural contexts and there are many analytical and computational approaches available. The majority of these approaches homogenize the fabric with bulk continuum properties. Whereas this can often be justified, especially if the fibers/yarns are captured in a matrix material or through coatings, it becomes less reasonable for flexible structures. The goal of this work is to incorporate a solid model for fiber/yarn geometries to study the effect of various parameters (for example friction - both at the yarn-crossover level and also between the various layers involved in a fabric structure) on performance. Another interesting aspect of this work is that the loading will be carried out as ballistic rather than quasi-static loading.

**other RESEARCH interests:**

- Rapid Tooling and Rapid Prototyping
- Time-Dependent Wear Properties of Vegetable Oils when used as Industrial Lubricants
- Mechanisms

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send email to: [keefe@me.udel.edu](mailto:keefe@me.udel.edu)

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## PUBLICATIONS

- JOURNAL PUBLICATIONS:

- Duan, Y., M. Keefe, T. Bogetti, B. Cheeseman, B. Powers, "A Numerical Investigation of the Influence of Friction on Energy Absorption by a High-Strength Fabric Subjected to Ballistic Impact," in-press: accepted for publication in the *International Journal of Impact Engineering* on 9 November 2004.
- Duan, Y., M. Keefe, T. Bogetti, B. Cheeseman, "Modeling Friction Effects on the Ballistic Impact Behavior of a Single-Ply High-Strength Fabric," *International Journal of Impact Engineering*, Vol 31, Issue 8, pp. 996-1012, 2005.
- Duan, Y. M. Keefe, T. Bogetti, B. Cheeseman, B. Powers, "Modeling the Role of Friction during Ballistic Impact of a High-Strength Plain-Weave Fabric," *Journal of Composite Structures*, Vol. 68, No. 3, pp. 331-337, 2005 (journal article corresponding to ACS 18th Annual Conference paper, October 2003).
- Tang, W., M. Keefe, "Stress Analysis and Structural Modifications of a Polyester Double-Tape Seam," *Journal of Materials: Design and Applications*, Proceedings of the Institution of Mechanical Engineers (Part L), Vol. 217, Part L2, pp. 101-112, 2003.
- Aluru, R., M. Keefe and S. Advani, "Simulation of Injection Molding into Rapid-Prototyped Molds," *Rapid Prototyping Journal*, Vol. 7, No. 1, February 2001.
- Li, Y., E. P. Gargiulo and M. Keefe, "Studies in Direct Tooling Using Stereolithography," *ASME Journal of Manufacturing Science and Engineering*, Vol. 122, No. 2, May 2000, pp. 316-322.
- Keefe, M., "Solid Modelling of Fibrous Assemblies: Part I, Twisted Yarns," *Journal of the Textile Institute*, Vol. 85, No. 3, pp. 338-349, 1994.
- Keefe, M., "Solid Modelling of Fibrous Assemblies: Part II, Woven Fabrics," *Journal of the Textile Institute*, Vol. 85, No. 3, pp. 350-358, 1994.
- Steiner, K. V., A. Wolff, and M. Keefe, "Interactive Graphics Simulation with Multi-Level Collision Algorithm", Technical Note, *Journal of Manufacturing Systems*, Vol. 11, No. 6, 1992 (journal article corresponding to SME Paper MS91-310, SME 4th World Conference on Robotics Research, September 1991).
- Keefe, M., D. Edwards and J. Yang, "Solid Modeling of Yarn and Fiber Assemblies", *Journal of the Textile Institute*, Vol. 83, No. 2, pp. 185-196, 1992.
- VanWest, B. P., R. B. Pipes, S. G. Advani, and M. Keefe, "The Draping and Consolidation of Cummiled Fabrics", *Composites Manufacturing*, pp. 9-22, March 1991.
- VanWest, B. P., M. Keefe, and R. B. Pipes, "A Simulation of the Draping of Bidirectional Fabrics Over Arbitrary Surfaces", *Journal of the Textile Institute*, Vol. 81, No. 4, pp. 448-460, 1990.
- Timmins, S. J., M. Keefe and J. R. Zimmerman, "Introduction to Mechanical Design: A User Friendly Approach to Computer Simulation", *Co ED Journal*, American Society for Engineering Education, Vol. 10, No. 1, 1990 (journal article corresponding to ASEE 1988 Annual Conference paper, June 1988).
- Timmins, S. J., M. Keefe and J. R. Zimmerman, "Educational Software for Mechanism Design", *Co ED Journal*, Computers in Education Division of the American Society for Engineering Education, Vol. 9, No. 2, April-June 1989.
- Keefe, M. and J. L. Houlton, "Penetration by Stretching Projectiles," *Journal of the Mechanics and Physics of Solids*, Vol. 36, No. 5, pp. 537-549, 1988.
- Kishore, A. and M. Keefe, "Synthesis of an Elastic Mechanism", *Mechanism and Machine Theory*, Vol. 23, No. 4, pp. 305-312, 1988.
- Keefe, M. and D. R. Riley, "Capturing Facial Surface Information", *Photogrammetric Engineering and Remote Sensing*, Vol. 52, No. 9, pp. 1539-1548, 1986.

- BOOK CHAPTER:

- "Geometric modelling of yarn and fiber assemblies", Chapter 4, pp.138-158, *Microstructural characterisation of fibre-reinforced composites*, Edited by John Summerscales, Woodhead Publishing Limited, CRC Press, 1998.

- PROCEEDINGS:

- Glancey, J., M. Keefe, N. Cloud, "A Case Study in Assessing Team-based Design Courses that

Integrate Industry-sponsored Projects: the University of Delaware Design Experience," accepted for Proceedings of IMECE2005, American Society of Mechanical Engineers, November 5-11, 2005, Orlando, Florida.

- Duan, Y., M. Keefe, T.A. Bogetti, B.Powers, "Modeling Ballistic Impact of a Lead Projectile onto a Flexible Fabric Laminate," accepted for American Society of Composites (ACS) 20th Annual Technical Conference, Paper No. 13, September 7-9, 2005, Drexel University, Philadelphia, PA.
- Duan, Y., M. Keefe, E.D. Wetzel, T.A. Bogetti, B. Powers, J.E. Kirkwood, K.M. Kirkwood, "Effects of friction on the ballistic performance of a high-strength fabric structure," International Conference on Impact Loading of Lightweight Structure, May 8-12, 2005, Forianopolis, Brazil, 2005.
- Duan, Y. M. Keefe, T. Bogetti, B. Powers, "Finite Element Analysis of Transverse Impact on a Woven Textile," IMECE2004-61694, Proceedings of IMECE 2004, ASME International, Technical Session TEX-3, Saturday, November 13, 2004, Anaheim, California, 2004.
- Duan, Y. M. Keefe, T. Bogetti, B. Cheeseman, B. Powers, "Impact and Simulation of Fabric Response," accepted for American Society of Composites (ACS) 18th Annual Technical Conference, Impact and Energy Absorptions Sessions, Gainesville, Florida, October 19-22, 2003. \*\*subsequently published in the *Journal of Composite Structures*.
- Tang, W., M. Keefe, "Stress Analyses and Structural Modifications of Fabric Composite Seams," IMECE2002-34487, Proceedings of IMECE'02, ASME International, November 17-22, 2002, New Orleans, Louisiana.
- Duan, Y., M. Keefe, T. Bogetti and B. Cheeseman, "Modeling the Impact Behavior of High-Strength Fabric Structure," Fall 2002 Annual Conference, the Fiber Society, October 16-18, 2002, Natick, Massachusetts.
- Glancey, J.L., M. Keefe and S. Zhang, "Performance of High Oleic Soybean Oil-Based Hydraulic Fluids in Long-Duration Pump Tests," SAE Paper No. 2000-01-2556, Alternative Industrial Lubricants and Additives (Session Code: F30-B), SAE International Off-Highway and Powerplant Congress and Exposition, Midwest Express Center, September 11-13, 2000, Milwaukee, Wisconsin.
- Aluru, R., M. Keefe and S. Advani, "Analysis and Simulation - Using Conductive Filler to Modify the Thermal Properties of Photopolymer Molds Made Using Stereolithography," 14th Annual Technical Conference of the American Society for Composites, Paper No. 59, Session 6B, University of Dayton, September 27-29, 1999, Dayton, Ohio.
- Timmins, S.J. and M. Keefe, "Performance Characteristics of the Porsche Boxster Mechanism," Proceedings of the 5th Applied Mechanisms & Robotics Conference, October 12-15, 1997, Cincinnati, Ohio.
- Li, Y. , M. Keefe and E.P. Gargiulo, "Studies in Direct Tooling Using Stereolithography," Proceedings of the 6th European Conference on Rapid Prototyping and Manufacturing, July, 1997, University of Nottingham, UK.
- Timmins, S.J. and M. Keefe, "Multi-Loop, Multi-Component Mechanism Performance Appraisal," Proceedings of the 4th National Applied Mechanisms & Robotics Conference, December 10-13, 1995, Cincinnati, Ohio.
- Means, S. and M. Keefe, "Load-Extension Behavior of Fabrics Utilizing Finite-Element Extensions," Proceedings of the ASME Textile Engineering Conference, October 9-10, 1995, Atlanta, Georgia.
- Means, S. and M. Keefe, "Finite-Element Simulation of Deformations in Woven Structures under Tensile Loading," 2nd International Conference on Composites Engineering, August 21-24, 1995, New Orleans, Louisiana.
- Jayanthi, Suresh, W. Harwin, V. Kumar and M. Keefe, "Application of Stereolithography in the Fabrication of Rehabilitation Aids," 6th Solid Freeform Fabrication Symposium, August 1995, University of Texas at Austin, Austin, Texas.
- Jayanthi, Suresh, M. Keefe and E.P Gargiulo, "Studies in Stereolithography: Influence of Process Parameters on Curl Distortion in Photopolymer Models," 5th Solid Freeform Fabrication Symposium, August 8-10, 1994, University of Texas at Austin, Austin, Texas.
- Horton, L., E. Gargiulo and M. Keefe, "An Experimental Study of the Parameters Affecting Curl in

Parts Created Using Stereolithography," 4th Solid Freeform Fabrication Symposium, August 9-11, 1993, University of Texas at Austin, Austin, Texas.

- Chettri, S.R., M. Keefe and J.R. Zimmerman, "Robost Statistics of the DLT," Proceedings of the SPIE - the International Society for Optical Engineering, v. 1822, pp. 86-97, 1993 (Conference November 15-16, 1992, Boston, Massachusetts).
- Yan, Z., M. Keefe and M. Piovoso, "Robust Adaptive Control and its Application to a Mechanical Manipulator," Proceedings: First IEEE Regional Conference on Aerospace Control Systems, May 25-27, 1993, Westlake Village, California.
- Allen, R.H., R.D. Cope and M. Keefe, "Reflecting on Our Senior Design Experience," Innovations in Engineering Design Education Resource Guide, Compendium to 1993 ASME Design Education Conference, March 24-26, 1993, Orlando, Florida.
- Vajapeyam, S. and M. Keefe, "Triangulated Surface Construction from Scattered 3-D Point", Proceedings of Computers in Engineering Conference, August 1992, San Francisco, CA.
- Edwards, D. C. and M. Keefe, "Solid Modeling of Fabric-Like Structures", Proceedings of CADCOMP'92, May 1992, Newark, DE.
- Gargiulo, E.P. and M. Keefe, "Visualization of Complex Surfaces," Proceedings of the Cooperative Working Group in Electronic Imaging of the Human Body, pp. 170-181, March 1992, Dayton, Ohio.
- Chettri, S. R., M. Keefe and J. R. Zimmerman, "Stereo Pair Design for Cameras with a Forea", Neural, Biological and 3-D Methods Session, Proceedings of Intelligent Robots and Computer Vision X, SPIE, November 1991, Boston, Massachusetts.
- Timmins, S. J., and M. Keefe, "A Unique Database Structure Allowing Mechanical Design Integration through Computer Simulation", Proceedings of 2nd National Applied Mechanism & Robotics Conference, November 1991, Cincinnati, OH.
- Steiner, K. V., A. Wolff, and M. Keefe, "Interactive Graphics Simulation with Multi-Level Collision Algorithm", SME 4th World Conference on Robotics Research, September 17-19, 1991, Pittsburgh, Pennsylvania.  
\*\*subsequently published in *Journal of Manufacturing Systems*, Vol. 11, No. 6, 1992.
- Chettri, S. R., M. Keefe and J. R. Zimmerman, "Obtaining Centroids of Digitized Regions Using Square and Hexagonal Tilings for the Photo-Sensitive Elements," Proceedings of SPIE's Advances in Intelligent Robotic Systems and Visual Communication and Image Processing, November 9, 1989, Philadelphia, PA.
- McWilliams, J. S. and M. Keefe, "Creating a Solid-Model Map of a Manipulator's Workspace", Proceedings of 1st National Conference on Applied Mechanisms and Robotics, November 6, 1989, Cincinnati, Ohio.
- VanWest, B. P., M. Keefe and R. B. Pipes, "The Draping of Bi-Directional Fabric Over Three-Dimensional Surfaces", Proceedings of the American Society for Composites, October 3, 1989, Blacksburg, Virginia.
- Keefe, M., S. Chettri and S. Vajapeyam, "Close-Range Stereo-photogrammetry Applied to Biological Surfaces," Proceeding of NCGA Conference, Vol. 1, pp. 149-157, Biomedical Applications, April 18, 1989, Philadelphia, Pennsylvania.
- Timmins, S. J., M. Keefe and J. R. Zimmerman "Educational Software for Mechanism Design", ASEE 1988 Annual Conference Proceedings, Session 3521, Vol. 5, pp. 1942-1946, June 21-23, 1988, Portland, Oregon. \*\*subsequently published in CoED Journal, Vol. 9, No. 2, 1989.
- Timmins, S. J., M. Keefe and J. R. Zimmerman "Introduction to Mechanism Design A User Friendly Approach to Computer Simulation", ASEE 1988 Annual Conference Proceedings, Session 1669, Vol. 3, pp. 1186-1192, June 21-23, 1988, Portland, Oregon.  
\*\*subsequently published in *CoED Journal*, Vol. 10, No. 1, 1990.
- Kishore, A. J., and M. Keefe, "Experimental Verification of an Elastic Synthesis Procedure," Proceedings, OSU's 10th Applied Mechanism Conference, Vol. 3, Session 7C, December 1987.
- Keefe, M., D. R. Riley, E. D. Rekow, T. M. Speidel, "Applying Automated Stereometric Digitization to the Human Face", ASME Conference for Medical Devices and Sporting Equipment, ASME DE, Vol. 1, pp. 74-80, October 1986, Columbus, Ohio.
- Rekow, E.D., M. Keefe, D.R. Riley, T.M. Speidel, "Automated System for Stereometric Three-

"Dimensional Digitization of the Human Face," Proceedings of the 1985 Society of Women Engineers National Convention, June 27-30, 1985, Minneapolis, Minnesota.

- M. Keefe, D. R. Riley, F. W. Worms, and T. M. Speidel, "Automated System for Stereometric Analysis of the Human Face," Biostereometrics 1982, Robin E. Herron, editor SPIE - The International Society for Optical Engineering, Vol. 361, pp. 15-21, 1983.
- D. R. Riley, F. W. Worms, T. M. Speidel, and M. Keefe, "A System for Analyzing Three-Dimensional Facial Form," 1981 Advances in Bioengineering, American Society of Mechanical Engineers, pp. 175-180, 1981.

• **MAGAZINES:**

- Keefe, M., D. R. Riley, E. D. Rekow and T. M. Speidel, "The Face in the Machine: Automated 3-D Stereo Measurement of Facial Form," *SOMA - Engineering for the Human Body*, Vol. 1, No. 4, January 1987, pp. 29-34.

• **non-published PRESENTATIONS:**

- M. Keefe, S. Means, "Modelling of Interfaces in Fibrous Structures," Mechanics Session, Fiber Society Meeting, November 15, 1994, Atlanta, Georgia.
- M. Keefe, D. Edwards, "Solid Modelling Applied to Fiber Assemblies," Computer Modelling of Textile Assemblies Session, Fiber Society Meeting, December 8-11, 1991, New Orleans, Louisiana.
- M. Keefe, of Van West, B.P., R.B. Pipes, "A Simulation of the Draping of Commingled Fabrics," International Conference on Fibre & Textile Science, April 10, 1991, Ottawa, Ontario, Canada.
- E. P. Gargiulo and M. Keefe, "A Plan for Teaching Experimental Vibration Analysis", presented at ASEE 74th Annual Conference, Engineering Acoustics and Vibration, June 1986, Cincinnati, Ohio.

• **SEMINARS:**

- "Assessing Team-based Courses: Case Studies," invited panelist with Robert Allen - Johns Hopkins and John Ochs = Lehigh, NCIIA 7th annual meeting, Cambridge, MA, March 20-22, 2003; Session 11am - Saturday, March 22, 2003.
- "Solid Modelling of Fibrous Structures," through Drs. I. Porat and J.W.S. Hearle, part of my sabbatical, University of Manchester Institute of Science and Technology, February 3, 1994.
- "Solid Modelling of Fabrics," Dept. of Textiles & Apparel and SAMPE, through Dr. Peter Schwartz and Ann Marie Sastry, Cornell University, April 2, 1993.
- "Education in Mechanisms: Software Issues for the Classroom," invited as one of three panelist, 22nd ASME Mechanisms Conference, September 13-16, 1992, Phoenix, Arizona.
- "Focusing on the Core," co-chairman and presenter, TBEEC 2nd Annual Meeting, November 7-8, 1990, Ohio.
- "Educational Software for Mechanism Design," CREATE presentation on Research in Computer-Based Learning - ACIT, February 6, 1989, Clayton Hall, University of Delaware, Newark, Delaware.
- "Integrating MCAE Software into the Academic Environment", invited as one of three panelists, SDRC User's Meeting, July 12, 1988, Cincinnati, Ohio.
- "Structured Light Approach to Measuring Facial Contours", Seminar for Department of Biomedical Engineering, Rutgers University, May 24, 1988, New Jersey.
- Laminate Composites capabilities of IDEAS Level 4.0, organized seminar at University of Delaware Composites Center, February 1988.
- "Stereophotogrammetric Approach to Generate Three-Dimensional Data", given at Primer Simposium Internacional de Ingenieria Mecanica y Electrica "Tecnologia Aplicada", October 1985.

• **OTHER PUBLICATIONS:**

- Clark, T., L. Dorney, M. Keefe, B. Amrein, P. Moore, V. Evans, "Wheelchair Access Device for Disabled Individuals," Poster for Human Factors and Ergonomic Society Conference, September 1997.
- Amrein, B., L. Dorney, H. Crowell, P. Moore, V. Evans, E. Herrman, M. Keefe, "Assistive Devices for the Disabled: A Partnership Approach," Poster for Human Factors and Ergonomic Society Conference, September 1997.
- Vajapeyam, S., M. Keefe, "Developing a Non-Convex Polyhedron Through Randomly Ordered Three-Dimensional Data", ME Department, University of Delaware, Laird CAE Report 2-88.

- o Chettri, S., M. Keefe, J. R. Zimmerman, "Obtaining Centroids of Digitized Regions Using Square and Hexagonal Tilings for the Photo-Sensitive Elements", ME Department, University of Delaware, Laird CAE Report 1-88.
- o Kishore, A. J., M. Keefe, "Synthesis of an Elastic Mechanism", ME Department, University of Delaware, Laird CAE Report 4-86.
- o Keefe, M., "A Computer-Assisted Tool to Semi-Automatically Generate Three-Dimensional Facial Soft-Tissue Information", Ph.D. Dissertation, University of Minnesota, Minneapolis, Minnesota, June 1985.
- **CONTRACTS & GRANTS:**
  - o "Friction Effects on Fabric Structures," Project CA3, CCM-ARL CMT, with Drs. T. Bogetti, B. Powers (ARL), and Y. Duan (Postdoctoral researcher), September 2001 - February 2006.
  - o "Mechanical Understanding of Seams - the Joints for Inflated Fabric Structures," Delaware Research Partnership - ILC Dover, with Dr. T-W. Chou, January 2001 - December 2002.
  - o "Chemical Degradation of Industrial Lubricants," 1998 Dupont Aid to Education, Biotechnology/Plant Sciences Committee, with Dr. J. Glancey and Dr. A. Szeri, June 1998-no end date.
  - o "Improving the Anti-Wear Properties of Soybean Oil Lubricants," Delaware Research Partnership - Dupont and the United Soybean Board, with Dr. J. Glancey and Dr. A. Szeri, Fall 1997 - 1998.
  - o "Mechanical Desktop Software Grant," Autodesk Inc., software only: three copies of Autodesk Mechanical Desktop add-on to AutoCAD with training materials, September 1996.
  - o "Product Realization Consortium Project," worked under Dr. D. J. Wilkins (PI), through Worcester Polytechnic Institute - NSF Realization Consortium, August 1995 to May 1996.
  - o "Modelling of Fabric Structures using FEA," Albany International - Press Fabrics, June to December 1994.
  - o "Multi-disciplinary Design & Analysis Methods," Co-PI with Dr. D. J. Wilkins and Dr. R. H. Allen, NASA - Phase I, January to December 1994.
  - o "Studies in Stereolithography," Grant-in-Aid with Dupont Company - SOMOS group, summer of 1993 and summer of 1992.
  - o "Solid Modelling of Draping," Graduate Student Internship Funding through Charles Stark Draper Laboratory - University of Delaware Composites Center, June to December 1991.
  - o "Undergraduate Mechanical Design Education through Intelligent Simulation," NSF Undergraduate Education, September 1989 to February 1991.
  - o "Studies in Stereolithography," Graduate Student Internship Funding through Dupont Company, January 1988 to December 1989.
  - o "New Mass-Focus Elements for EPIC Code," Honeywell Company, February 1988 to December 1988.
  - o "PC Based Introduction to Mechanisms," Office of Computer-Based Instruction - University of Delaware, September 1986 to August 1988.
  - o "Developing Surface Generation to Create a Solid-Geometric Component Database," University of Delaware Research Foundation, January to December 1986.
  - o "Modify Performance-Evaluation Codes," Naval Surface Weapons Center - White Oak, February to April 1986.
  - o "Automatic Re-mesh/Re-zone Technique for EPIC code," Honeywell Company, April to September 1986.

send email to: [keefe@me.udel.edu](mailto:keefe@me.udel.edu)

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**UNDERGRADUATE RESEARCH & INDEPENDENT STUDY:**

- Matthew Decker - shear-thickening fluids study, 2nd reader (Dr. Norm Wagner, CHEG, advisor), undergraduate thesis, 2005-2006.
- A. Salaita - experimental work = Instron testing of yarn-yarn friction - in support of ARL/CCM: CMT-CA3, Friction Effects on Fabric Impact, Summer 2005.
- A. Salaita, T. Pepe - manufacturing work in support of ARL/CCM: CMT-CA3, Friction Effects on Fabric Impact, hourly, Fall 2004, Winter 2005.
- A. Salaita - experimental work in support of ARL/CCM: CMT-CA3, Friction Effects on Fabric Impact, ~full time, Summer 2004
- C. Collins-Chase, J. Kirkwood, K. Kirkwood - CHEG, 3rd reader, 2003-2004.
- James Moore, Matt VanHorn, Matt Reber - experimental work in support of ARL/CCM: CMT-CA3, Friction Effects on Fabric Impact, each ~1/3 time, Summer 2003.
- Dan Gleeson, Jon Watts - design development, biaxial fabric grips, ILC Dover, Spring 2003, MEEG466 (also D. Forney working on publication related to same).
- Dirk Veenema - evaluation of an integrated fuel cell - turbine power generating system, 2nd reader (Dr. Hai Wang = advisor), undergraduate thesis - 2002-2003.
- I. Mizra - EE, K. Wood - BioResources E, 3rd reader, 2002-2003.
- James Moore - design of fabric sample cutting system and testing of fabric seam samples for ILC Dover, Summer 2002.
- Rob Storey and Nick Grossman - testing of wheelchair and design of portable crib; with Dr. Dick Wilkins, for Sitting Pretty, Inc., Summer 2002.
- Matt Eskridge - design development, automation system, Air Products, Spring 2002, MEEG466.
- Tom Shipman - bias testing and modeling in fabrics, Winter 2002, MEEG445 - Science and Engineering Scholar.
- Nikki Rossi - real-time sensor, with Dr. J. Glancey, Summer 2001, MEEG445 - Spring 2001; low-volume pump test work, with Dr. J. Glancey, Winter 2001, Summer 2000, Winter 2000, Summer 1999.
- Tom Shipman, Jim Moore - mechanical response of fabrics, with ILC, Summer 2001 (T. Shipman - UD Science and Engineering Scholar).
- Sean Bullard, Shaun Curry - prototype design of collapsing wheelchair, with Sitting Pretty, Inc., Summer 2001.
- J. Davis and H. Johnson - CHEG, 3rd reader, 2000-01.
- Ryan Meers, Matt Blaisdell - design to reality of wheelchair/walker concept, with Sitting Pretty, Inc., Spring 2000.
- Andy Parke - NC link to CAD lab, with Dr. Jim Glancey, Fall 1999.
- M. Bray - EE, R. Khan and D. Ramanan - COMP ENG, D. Kravitz - MATH, J. Witkoskie - CHEM, A. Uri - GEOL, 3rd reader, 1999-00.
- Jim Wert - simulate manuf. process control for Lear, with Dr. Bill Fagerstrom, Spring 1999.
- Ray Foulk - composites manufacturing, "fuzzy" control, 2nd reader (Dr. Jack Gillespie = advisor), 1998-1999.
- Scott Suhmann - walking machine, Fall 1997 (with Dwayne Turley EE - Dr. Foulds)
- A. Caro - CSCI, B. Intiyot - MATH, K. Strelein - EE, 3rd reader, 1997-8
- J. Mike Tate - FEA of stringed instruments, co-advisor with Mr. Oliver Rodgers, 1997
- Ken Miller and Rob Banks - study device to inject chickens, co-advisor with Dr. James Glancey, 1997
- C. Brian Klinetob - FEA analysis of fiber/fiber interface, 1996
- Thomas Stapleford - force-based computer input, co-advisor - A.I. Dupont, 1996
- R. Dagastine, N. Haubein, J. Quirin, A. Scurto - CHEG, C. Sherwin - CSCI, 3rd reader, 1996-7
- Karen Hada - force based mouse input device, co-advisor - A.I. Dupont, 1996
- Eric Benson - Ag., alternate uses for veg. oil, 2nd reader (Dr. Jim Glancey = advisor), 1996
- Eric Mei - ME, robot control joystick, co-advisor - A.I. Dupont, 1996
- M. Weaver - CSCI, A. Semiao, T. Saunders - EE, 3rd reader, 1995-6
- Tanya Swiderski - nonlinear FEA of Fabric Structures, 1995
- R. Martin - MATH, M. Flynn - AG., M. Conte, S. Basu - EE, 3rd reader, 1994-5
- James Stewart - practical robotics, 1995

- Stephanie Means - FEA of Monofilaments and Fabric Structures, 1994
- Leslie Horton - Experimental Study of Stereolithography, looked at curl, GTE Scholarship, 1994.
- Anthony DelNegro - Mechanical Aspects of Stereolithography, "Stereolithography for Photoelastic Stress Analysis," Anthony DelNegro and E. P. Gargiulo, The Fourth International Conference on Rapid Prototyping, Dayton, Ohio, June 14-17, 1993.
- Ernest Jones - experimental textile shear, 1992
- Damian Repolle - Gore-Tex breather vent, 1990
- John McWilliams - solid modelling of manipulator's workspace, 1989
- Jim Smoker - workspace of manipulator as a volume, 1988
- Steve Timmins - educational/interactive mechanism PC program, 1987
- Malcolm Hunter - machining simulator with solid modelling, 1987
- Jim Beck - robotic lab for MEEG391, 1987
- Mike Qaissaune - bias and tension in cubic splines, 1986

#### **current GRADUATE STUDENTS**

- Yiping Duan, Ph.D., Postdoctoral student - simulating ballistic impact on fabrics.

#### **GRADUATE SUMMARY**

- W. Tang, MSME, "Stress Analyses and Structural Modifications of Fabric Composite Seams," August, 2002.
- R. Aluru, MME, "Simulation of Injection Molding Into Photopolymer Molds Built by Stereolithography," December, 1999.
- Y. Li, MME (co-advisor with Dr. E. Gargiulo), "Studies in Direct Tooling Using Stereolithography," August 1997.
- S. Timmins, Ph.D., "The Decomposition Approach to Mechanism Analysis and Its Application to Sensitivity Performance," May 1997.
- S. Jayanthi, MME, "Studies in Stereolithography: Influence of Build Process Parameters on Curl Distortion," May 1995.
- S. Vajapeyam, Ph.D., "Solid and Surface Reconstruction from Random, Scattered 3-D Data," December 1993.
- Z. Yan, Ph.D. (industry contact - Dr. M. Piovoso), "Robust Adaptive Control of a Mechanical Manipulator," May 1993.
- D. C. Edwards, MME, "The Solid Modelling of Fabric-Like Structures," May 1992.
- S. Chettri, Ph.D. (co-advisor with Dr. J. Zimmerman), "Error, Accuracy and Quality Control Aspects of Computer Vision Measurements," May 1990.
- J. Hirsch, MME (industry contact - Dr. E. Gargiulo), "Studies in Solid Imaging: Optical Curing of Photopolymers to Create Three-Dimensional Solid Models," May 1990.
- K. Steiner, MEE (thesis advisor), "Computer-Graphic Robotic Manipulator Simulation with Collision Detection," August 1989.
- S. Vajapeyam, MME, "Developing a Non-Convex Polyhedron Through Randomly Ordered Three-Dimensional Data," May 1989.
- A. Dungan-Reimers, MME (industry contact - Dr. E. Gargiulo), "A Unified Approach to Modeling the Dynamic Characteristics of an Actively Controlled Vertical Rotor," December 1987.
- A. Kishore, MME, "Synthesis of an Elastic Mechanism," May 1987.

send email to: [keefe@me.udel.edu](mailto:keefe@me.udel.edu)

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**SERVICE (current and highlights):**

- **Membership in Professional Societies**
  - American Society of Mechanical Engineers (ASME)
  - National Society of Professional Engineers (NSPE)
  - Fiber Society
- **Departmental**
  - Associate Chairman for Undergraduate Education, September 2000 - current
  - Computer Committee
  - Undergraduate Advisory/ABET Committee (chairman)
    - Undergraduate Departmental Advisor, 1991-1993; 1997-2000
- **College**
  - Educational Activities Committee
    - Chairman, 1997-1998
  - Engineering Outreach Advisory Committee
  - ABET EC 2000 Advisory Committee
  - eCALC Committee (chairman)
- **University**
  - Faculty Senate
    - Parliamentarian, 2003-2004
    - Committee on Committees and Nominations, Chairman 2001-2003
    - Academic Priorities Committee, Chairman 2000-2001
    - President, 1998-1999
    - President-Elect & Chairman, Coordinating Committee, 1997-1998
    - Vice President, 1995-1996
    - Chairman, Undergraduate Studies Committee, 1991-1993
    - Senator, 1987-1989
  - University Honors Program, Senior Thesis Board 1994-1998, 1999-2001, 2002-2004
- **Local**
  - grade school and high school presentations on engineering
  - classes on word-processing, 7th grade
- **State**
  - Professional Engineer, Registration No. 10328, State of Delaware
  - 2005 Engineer of the Year
  - Delaware Engineering Society (DES) - Board: Professional Engineers in Education, 2003-
  - ASME Delaware Section - Executive Board, Program Chairman
    - Program Chairman, 2003-2004
    - Treasurer, 2002-2003
    - College Relations, 1996-2002
    - Treasurer, 1991-1996
    - Chairman/organized 1995 Graduate Student Technical Conference for Region III
    - Region III Operating Board, Technical Activities, 1992-1994
    - Chairman, 1989-1990
    - Vice-Chairman, 1988-1989
- **National**
  - ASME Design Division, Education Committee
    - Organize and run: Young Design Engineer's Paper Competition, co-sponsored by Old Guard and Design Engineering Division, 1990-1993, 1995-2002
    - Treasurer, 2001-current
- **Have Reviewed for:**
  - ASME Computers in Engineering Conference
  - ASME Design Automation Conference
  - ASME Design Engineering Conference
  - ASME Journal of Biomechanical Engineering

- o ASME Journal of Mechanical Design
- o ASME Mechanisms Conference
- o ASME Young Design Engineer's Paper Competition
- o ASME Design Division, Successes in Mechanical Engineering Design Education
- o Composites Science and Technology
- o IEEE Transactions on Biomedical Engineering
- o Journal of Microscopy
- o Journal of the Textile Institute
- o Jury Member for 1993 Lincoln Arc Welding Foundation Professional/Graduate/Undergraduate Awards
- o McGraw-Hill, manuscript for "Design of Machinery," 2nd edition - Chapters 1-8, 1st edition - 3 chapters
- o NRC proposal
- o NSF Division of Undergraduate Education, ILI Program, 1993 & 1995
- o NSF DMI-II UNSOL Solid Free-Form Fabrication Program, April 17th, 2001
- o NSF proposals, Dynamic Systems and Controls Division of Mechanics, Structures and Material Engineering
- o Prentice Hall, manuscript for "Design Theory and Practice," chapters for "Mechanical Desktop"
- o Textile Research Journal

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**CONSULTING**

- Morris, Nichols, Arsh and Tunnell; patent infringement
- Foley and Lardner, patent infringement
- Albany International, solid modeling of fabrics
- Jack Vinson / Kessler and Cohen, product safety
- Dupont, 3-D imaging of complex shapes
- Honeywell, shell elements with strength in EPIC 2
- Dyna East, graphics for user interface
- Honeywell, automatic re-mesh/re-zone of EPIC 2
- NSWC White Oak, modify PEC codes

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**CERTIFICATE OF SERVICE**

I, Rodger D. Smith II, hereby certify that on November 15, 2005, I caused to be electronically filed Declaration of Michael Keefe, Ph.D., P.E. (Redacted Version) with the Clerk of the Court using CM/ECF, which will send notification of such filing(s) to the following:

Josy W. Ingersoll  
Young, Conaway, Stargatt & Taylor, LLP  
The Brandywine Building  
1000 West Street, 17th Floor  
P.O. Box 391  
Wilmington, DE 19899

and that I caused copies to be served upon the following in the manner indicated:

**BY HAND**

Josy W. Ingersoll  
Young, Conaway, Stargatt & Taylor, LLP  
The Brandywine Building  
1000 West Street, 17th Floor  
P.O. Box 391  
Wilmington, DE 19899

**BY FEDERAL EXPRESS**

Thomas J. Meloro, Esquire  
Kenyon & Kenyon  
One Broadway  
New York, NY 10004

*/s/ Rodger D. Smith II*

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Rodger D. Smith II (#3778)  
Morris, Nichols, Arsh & Tunnell  
1201 N. Market Street  
P.O. Box 1347  
Wilmington, DE 19899  
(302) 658-9200  
rsmith@mnat.com